Matching Genetic Potential to Feed Resources

by Jim Gosey, University of Nebraska, Lincoln

"One of the worst things in the world I've ever tried to do is communicate with people that have an idea of what it costs them to produce cattle . . . they are driven by things that are non-economic, things that are very difficult to seriously discuss."

"Matching genetic potential to feed resources—it's very important how this is said. We are not matching feed resources to genetic potential. That is, in fact, backwards."

"Biologically, it is most efficient to feed the calf directly, but economically it's often more efficient for that cow to consume the low-quality feedstuff to produce milk to feed the calf."

"Economic efficiency equals input cost per unit of beef output."

"Are fixed costs fixed to the enterprise or to the cow?"

"Cow size—by itself—doesn't have much of an impact on economic efficiency. . . . Optimum cow size can be determined by adaptability."

Dr. Jim Gosey, extension beef specialist and assistant professor of animal science at the University of Nebraska, is a well-respected spokesman on the issues of optimums vs. maximums and economic efficiency. The following article summarizes information he presented to several audiences, including those at last year's Cornbelt Cow-Calf Conference, Winrock International Stockmen's School and Jorgensen Angus sale.

The era of maximum beef production, where minimal attention was paid to economic efficiency or the optimum use of land, cattle, labor and capital, has ended. The maximum production era, based on low-cost inputs and predictions of ever-greater consumer demand for beef, was certainly fun while it lasted.

Many cattlemen will enter a new era of economic efficiency in beef production by necessity, not choice. Survival may sound like a harsh word to characterize the beef industry, but survival it is. The economic efficiency era will be characterized by cattlemen who define economic optimum levels of performance in traits which affect net profit. And they will do this within the limits of their own resources. Resources can be limited in absolute terms due to low rainfall, poor soil, etc., but the vast majority of resources put into cattle are limited by cost.

Since feed resources account for a major share of input costs and are the basic resource upon which the beef enterprise is built, finding the optimum "match" between cattle genetics and economically available feed resources is vital to total economic efficiency. I know of no magic formula which will exactly define the most economically efficient "match," but I offer some thoughts which may help cattlemen define an optimum production range for each trait impacting net profit within their resources.

Feed resource utilization

On the surface, the apparent poor conversion of feed energy to lean product by beef cattle as compared to other meat-producing species (pigs, poultry and rabbits) is discouraging. However, cattle have the ability to convert low-quality forages to high-quality lean beef. In fact, about 88 percent of the total life-cycle feed energy needs of beef cattle can be met by grazed or harvested forages which cannot be utilized by non-ruminant animals. This is not only an encouraging fact for the Western United States with its vast expanse of rangelands, but also for the Midwest where large quantities of low-quality crop residues are a by-product of grain operations and can be effectively harvested by beef cattle.

Cattle are the best harvesting machines for millions of acres of stalk fields, woodlands and other land areas too wet, too steep, too rocky or too sandy to till. The fact that cattle are scavengers which can utilize these low-value feedstuffs will undoubtedly be the salvation of beef cattle as food producers.

A cattleman seldom can let demands of a production system pull him too far away from his **economically available** forage resources without incurring substantial economic risk. Judicious use of pasture improvement techniques, strategic supplemental feeding and other cost-effective technology is not ruled out. There is, however, a *big* difference between using cattle to package the forage your land can economically produce and manufacturing feed to support the needs of a type of cattle you may happen to like. In other words, feed resources should play a major role in dictating the production levels for various traits and the kinds of cattle for profitable production.

Economic vs. biological efficiency

All too often, considerations of "efficiency" and, in particular, "cow efficiency" have been made solely in biological terms (such as feed input/beef product output). Little attention has been paid to the net effect of economic efficiency, defined as total input costs/total beef product output. And traditionally, output has received the greatest emphasis in selection programs as cattlemen sought to maximize pounds sold. Until recently, the important other side of the efficiency equation (input cost) was largely ignored. The sobering realization that maximum output usually does not result in maximum net profit dictates that input must be considered in conjunction with output.

Crossbreeding exemplifies this. It is a potent genetic tool for improving efficiency of production, but when all inputs are considered as well as output, the total net effect on economic efficiency is about one-third that of the total effect on output per cow. This serves as an excellent illustration that a change in production technology which increases output does not automatically translate to an equal increase in economic efficiency.

Expression of profits and costs

Cattlemen don't survive economically because of profit per head, per acre or per pound. Net profits of $20 per head on 300 head, and $30 per head on 200 head yield the same net return. While it is easy to measure performance on a per head basis, a better guide to profitability would be performance per unit of "fixed" resource use. Profit is the total income left (after "out of pocket" costs are paid) to pay for the total fixed resource package, including

A Recap

1. There is an optimum cow size and milk production level for a given feed resource. Reproductive rate is the "warning flag" to indicate mismatches. Greater size and milk production will lower carrying capacity—there are no free lunches!
2. Market requirements (carcass weight, yield grade and quality grade) and specific adaptation differences will help determine optimum size. Once cattle are large enough to produce carcasses which fall within the range of acceptable market weight specifications, there is no further need to increase size. Size, by itself, has practically no impact on economic efficiency.
3. The range of optimum milk production level is much wider in abundant feed environments than in sparse feed environments. Cows with higher milk production potential apparently require more feed even during the dry period than do lower milking cows.
4. Milk level and growth should be adequate to allow the producer to have flexibility in the time of marketing his calves. Flexibility in marketing options is the only realistic way to take advantage of price differences which may arise between the cost of cow herd feed and feedlot feed.
5. For maximum economic efficiency, commercial cows should be moderate enough in size to allow mating a portion of the cow herd (the older cows) to terminal sires of relatively greater growth and carcass leanness. Cow herds composed of large-sized cows eliminate the advantage of this option.
6. Breed differences need to be preserved. There is no need to spend 30 years redesigning a breed in the image of an original breed when the original breed is available to be used immediately. Seed stock breeders need to define the role of their breed (or line within a breed) in terms of their potential contribution to commercial beef production.
7. A concerted effort to increase net reproductive rate, within the limits of economically available resources, and to increase the relative growth rate of market cattle **only** by the use of terminal-sire crossbreeding systems would seem to have the best chance of improving economic efficiency in the beef industry.

"There are upper and lower limits, but once you're within that acceptable market weight, there's no further need to change size because all you're doing is playing the yo-yo that dips with fads and fancies."

"If size is so important in ruminants, somebody please explain to me why we have sheep . . . "

"Too many people get in a 'bucket feeding' situation, that is they fit resources to support the kind of cattle they like, not the kind that fit the resources."

"There's no reason we should all raise cattle that are alike, as long as they are economical and make money for us."

"We cannot give ground on reproductive rate . . . we can give ground on size (to fit market weight) and milk (to fit reproductive rate)."

"On profit priorities: We need to evaluate feed resources and marketing plans. We need to develop a management plan. And then we need to make the cattle fit the above."

farm/ranch equity and management effort.

Fixity of costs and/or resources is important in the quest for greater efficiency. Efficiency is generally improved by manipulating that which is "variable" to get more net return from that which is "fixed."

The pertinent question concerning "fixed" costs is, "What are fixed costs fixed to?" Although any cost can be "expressed" on a per head basis, such a description does not mean that it is "fixed" on a per head basis. For example, if $1,000 is spent on fencing and facility repair per year in a 100-cow herd, this cost could be expressed as $10/cow/year; but it is not "fixed" on a per cow basis because the same total cost would be incurred whether there were 80, 100 or 120 cows. Feed-associated costs (forage-harvesting machinery, for example), whether they are expressed as fixed or variable costs, are acually fixed to a given feed supply. Thus, such costs are variable on a per-cow basis, (depending on cow size and milk level), but fixed to the ranch and unaffected by whether a given feed supply is consumed by more small cows or fewer large cows.

Obviously, some costs are truly fixed on a flat rate, per-cow basis; personal property taxes, identification costs and breeding costs are a few examples. Such costs favor running fewer cows of higher levels of production. However, if an important share of so-called "fixed" costs are fixed to the beef enterprise, then expressing such costs on a per-cow basis could be misleading in evaluating economic efficiency between cows of different production levels.

Size, by itself, has practically no impact on economic efficiency.

Impact of size and milk on efficiency

Research through simulation of beef production systems shows no single optimum milk level. Instead, a range of potentially optimum milk levels exists for any given environment. To define this range, it appears that cows should give at least enough milk to essentially maximize calf survival and weaning rate. Higher levels of milk production could be desirable, but milk production should not be increased beyond the point where reduced fertility begins to reduce weaning weight per cow exposed. Potential milk level should be adequate for calf survival and early growth, but low enough to permit acceptable breeding condition during lactation. Thus, the optimum range of milk production is much wider in good feed environments than in limited feed environments.

Within the suitable range of milk production levels, the specific optimum point is a function of the price ratio of forage to feedlot TDN. This reflects the fact that nutrients can be provided either to the calf directly (postweaning or creep feed) or indirectly (milk produced from forage by the cow). It is usually **biologically** most efficient to allow the calf to consume nutrients directly, but it is often **economically** more efficient to have the cow convert low-cost, low-quality roughage into high-quality milk for the calf. If the postweaning ration is cheap relative to pasture costs, then relatively low milk levels are desirable in order to produce as many calves as possible to be fed out on the cheap ration. If postweaning feed costs are high, however, it is desirable to maximize preweaning weight.

Researchers at the U.S. Meat Animal Research Center (MARC) obtained some startling results in a basic investigation of the partitioning of feed energy by various breed types of cows. Results suggest that heavy-milking breed types have higher maintenance requirements per unit of metabolic weight than do cows of lower milk production. Cow size by itself had little influence on maintenance requirements when expressed in this manner (i.e., per unit of metabolic weight).

The MARC study found fairly small differences in energy used for lactation and gestation; the major differences were in maintenance energy for the cow and in postweaning feed usage of calves. The moderate size, moderate-milking breed type, represented by Angus-Hereford cross cows, required 33 percent less feed energy to produce market progeny to a constant marbling end point than Simmental-cross cows.

In general, simulation of beef production systems has shown that mature body size, alone, has little relationship to life-cycle efficiency in straight breeding or rotational crossbreeding systems. However, figures indicate that large, terminal-sire breeds mated with older cows of smaller, maternal breeds to produce only market calves can definitely increase production efficiency.

Larger or smaller body size may have very important biological advantages for adaptation to climate, feed resources, marketing specifications and maternal/paternal use in crossbreeding programs. Larger body size may have advantages in tolerance of cold stress and in more efficient use of abundant feed supplies, whereas smaller size may be an advantage in hotter, drier climates with sparse seasonal grazing.

Optimum performance

Optimum performance is not a single-trait phenomenon; it is a multiple-trait phenomenon. It is not sensible to apply selection on a single trait to the ultimate selection limit; there are too many trade-offs involved. Thus, the realistic approach seems to be selection for optimum performance levels in traits important to economic efficiency.

Neither maximum nor minimum levels of performance are optimum for many traits affecting economic efficiency of beef production. Such is the case with birth weight, where calves that are too light at birth tend to have higher mortality due to failure to cope with stresses, while those that are too heavy at birth have higher mortality due to calving difficulty. Clearly, intermediate birth weights are optimum to maximize calf survival.

Serious genetic antagonisms result from the high genetic correlations among weights at birth, weaning, yearling and mature ages. Heavier weaning and yearling weights are obviously favorable in terms of gross income. However, selection for growth at weaning or yearling ages increases birth weight and mature size. Heavier birth weight increases calving difficulty, reduces survival and reduces rebreeding performance of dams. Heavier mature weight of cows increases gross output of the system, but it also increases feed requirements; advantages are at least partially offset.

Seed stock breeders need to define the role of their breed (or line within a breed) in terms of their potential contribution to commercial beef production.

Selection objectives for a breed, or line within a breed, should depend on the breeding system used in the commercial herds being supplied with seed stock. General-purpose breeds are needed to serve commercial straight breeding or rotational crossbreeding programs. More specialized maternal breeds and terminal-sire breeds are needed if commercial operations use the principle of complementarity.

Currently, too many breeders are selecting bulls as if they were all to be used as terminal sires. Careful analysis of the specific needs in crossbreeding programs reveals some clear differences that should be applied in terms of selection emphasis in maternal, general-purpose and terminal breed types. An outline of how selection emphasis in seed stock herds might differ between breed types follows:

Terminal breed types
- rapid lean growth
- extremes in birth weight and mature size avoided
- reasonable level of fertility and functional soundness
- disposition

General-purpose breed types
- fertility and calving ease
- limited selection for growth and milk
- disposition
- functional and structural soundness
- adaptability and fleshing ability

Maternal breed types
- fertility and calving ease
- disposition
- functional and structural soundness
- adaptability and fleshing ability
- longevity
- maintaining milk and growth (depending on feed environment)

The basic question is, "Why spend a lifetime of selection in a maternal or general-purpose breed type trying to remake it into a terminal breed type that already exists as another breed?"

Competitive and psychological pressures to increase outputs are very compelling in the beef industry. However, once optimum levels of size and milk production have been achieved—by selection between or within breeds—terminal-sire crossbreedings systems provide the best method available for exploiting genetic variation in size and growth to increase efficiency. Thus, intensive selection for more rapid and efficient growth rate can only be justified in terminal-sire breeds.

In maternal and general-purpose breeds, it is appropriate to stress fertility more than any other trait in spite of its low heritability. This is because of the tremendous importance of fertility or net reproductive rate to economic efficiency. General-purpose breeds should receive limited selection for growth, but only to the point where progeny meet market requirements (carcass weight, cutability, quality grade); further selection brings unwanted increases in birth weight and mature size.

Utilization of genetic resources

Commercial cattlemen have the opportunity to choose genetic resources from a vast array of breeds and types within breeds. Although substantial variation does exist within some breeds, the old adage that "there is more variation within a breed than there is between breeds" is simply not true for the total range of production traits which affect economic efficiency of the beef enterprise. The choice of breed or breeds to be used remains a critical decision to economic efficiency. A thorough understanding of breed production differences and the potential role of various breeds in the production system is imperative to matching genetics to feed resources. AJ